winding up with a trip round the harbour, with its men-of-war, dockyards, forts, and factories. The Government establishments are always open to English folk. Our foreign friends who may desire to go over them, will have to provide themselves with a special order. There will be also a trip to Liskeard, for the Caradoc and Phœnix mines, and the famous Cheesewing. As mining is the special industry of Cornwall, and to a great extent of South Devon, it has been thought desirable to have two mining excursions—one on each day. South Caradoc is one of the richest copper mines in Cornwall ; Phœnix is a tin mine ; and both are admirably managed and excellently adapted to illustrate mining operations. The mineralogy of this district has some peculiar features. Phœnix has lately yielded the rare minerals chalcosiderite, andrewsite, and the beautiful turquoise-hued henwoodite. The third excursion will be to the Lee Moor China clay works. These are situated on the skirts of Dartmoor, not far from Plympton, are of immense size, and afford probably the best illustration of this great industry, which Cornwall and Devon owe to the researches and ingenuity of Cookworthy, chemist and potter, manufacturer in the Plymouth china of the first true English (hard) porcelain. It is likely that this excursion will be taken up by the Plymouth Institution, and so arranged as to embrace a visit to Princetown, and its convict prison, and some of the fine prehistoric antiquities of Dartmoor ; if not there will probably be an extra excursion with this object given by the institution.

Thursday will be a long day, and wholly given up to excursion pleasures. The mining excursion will be up the lovely river Tamar to Devon Great Consols, which communicates by a railway of its own to shipping quays at Morwellham, in the close vicinity of the most picturesque scenery of the Tamar valley. On the way, by the kindness of the Countess Dowager and the Earl of Mount-Edgcumbe, the party will have an opportunity of inspecting Cotehele, one of the most perfect examples of a mediæval mansion now extant. At Devon Consols—not long since the largest and richest copper mine in the land, which gave in dividends considerably over a million —not only are mining operations conducted on the most extensive scale, but there are enormous arsenic works, huge water-wheels, and many other objects of interest. The other excursions arranged for the day are to Torquay and Penzance. The good people of Torquay intend to follow the capital precedent set in 1869, and to invite and entertain a number of guests. *En route* from Plymouth a steamer trip may be made down the lovely river Dart ; and at Torquay there are plenty of objects of interest. The Torquay Natural History Society has a well-stored museum ; Kent's Cavern is of course a museum in itself, with a very Cerberus of a curator in Mr. Pengelly ; and then there are the works of Mr. Froude, F.R.S., at Chelson Cross, where he conducts those delicate experiments for the Admiralty on the forms of ships and their properties of stability, and to which he intends to invite members of the Association who are specially interested in this branch of mechanical science. Steps are, we believe, being taken at Penzance to give the excursionists thither a hearty welcome. The museums of the Penzance Natural History Society and of the Royal Geological Society of Cornwall, the latter of which contains the best public mineralogical collection in the West of England will be thrown open to them, and excursions in all probability organised to the chief attractions of the neighbourhood. It is hoped to provide special railway facilities for those who may wish to visit other parts of the country—such as Tintagel or the Lizard, or the western mining district. At Truro is the excellent museum of the Royal Institution of Cornwall, which will be open to visitors.

The former meeting at Plymouth, of the Association, was in 1841, with Dr. Whewell, as president, and was a very successful gathering. Six-and-thirty years are a long time, and it is remarkable that so many who took a prominent part on that occasion are yet with us. One of the vice-presidents still survives—the Earl of St. Germans ; two of the local secretaries, Mr. R. W. Fox, F.R.S., and Mr. R. Taylor, F.G.S. ; a vice-president of the statistical section, the Earl Fortescue, then Viscount Ebrington ; Dr. Owen, F.R.S., vice-president for Zoology and Botany ; and Mr. Robert Hunt, F.R.S., then secretary of the section of Chemistry and Mineralogy, are still with us. There will not be wanting opportunity, therefore, of comparing personal experiences in 1841 and 1877.

INDIAN RAINFALL AND SUN-SPOTS

ON May 24 Gen. Strachey read a paper before the Royal Society entitled " On the alleged Correspondence of the Rainfall at Madras with the Sun-Spot Period, and on the True Criterion of Periodicity in a Series of Variable Quantities."

He stated that a paper had recently been printed by Dr. Hunter, the Director-General of Statistics to the Government of India, having for its object to show that the records of the rainfall at Madras, for a period extending over sixty-four years, establish a cycle of rainfall at that place which has a marked coincidence with a corresponding cycle of sun-spots—the rainfall and sun-spots attaining a minimum in the eleventh, first, and second years, and a maximum in the fifth year.

The Madras register extends over sixty-four years, beginning with 1813. The mean rainfall for the whole period is 48·5 inches. The deviations from the mean vary from 30·1 inches in defect to 39·9 inches in excess. The arithmetical mean of these deviations (disregarding the signs) is 12·4 inches.

Dr. Hunter divides the sixty-four years' observations into six cycles of eleven years, and calculates the arithmetical mean of the successive years of the whole series of cycles. The results are as follows :—

	Years of cycles of eleven years.										
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.
Average difference from the mean of 64 years.	in. +0·6	in. +0·7	in. +9·8	in. +2·4	in. +1·9	in +5·8	in. +4·4	in. −3·4	in. −11·5	in. +0·7	in. −13·5

In the above calculation the first year of the cycle of eleven is 1813, so that the average period of maximum sun-spots will be about the third or fourth year of the cycle, and the period of minimum will be about the tenth or eleventh of the cycle. This table apparently indicates a period of maximum between the third and the seventh years, and of minimum between the eighth and the second years.

But as the only signification of the arithmetical mean value of a series of observed quantities is that it is one above and below which there is an equal amount of deviation in the individual observations, the question whether or not the mean values thus obtained can be accepted as showing a definite law of variation from year to year in the cycle must be determined by examining the differences between those means and the individual observations on which they are based.

Treating the observations in this manner, it appears that the mean difference of the individual observations from the means shown in the table amounts to 11·2 inches, and differs but little from the mean difference of the individual observations from the arithmetical mean of the whole series. In other words, the supposed law of variation obtained from the means of the six eleven-year cycles hardly gives a closer approximation to the actual observations than is got by taking the simple arithmetical mean as the most probable value for any year.

In order to obtain a practical test of the probable physical reality of the cycle of eleven years, the author calculated a series of mean values corresponding to those given in the table for a series of cycles of five, six, seven, eight, nine, ten, twelve, and fourteen years. The mean differences between these means and the observed quantities are all within a very small fraction of one another, and of the mean obtained from the eleven-year cycle—

in short, one cycle is in this respect almost as good or as bad as another.

Now, if in any series of quantities, such as the rainfall observations at Madras, there be a law of periodicity, each observed quantity may be supposed to be compounded of a periodical and a non-periodical element. If we take the sum of a large number of cycles, each of which coincides with the cycle of periodicity, the non-periodical elements will tend to be eliminated, and the means for the successive years of the cycle will indicate the periodical elements for the successive intervals. At the same time the differences of these means from the several original quantities from which they were obtained will be the several non-periodical elements.

In proportion as the periodical elements are small or large in relation to the corresponding non-periodical elements, so the differences (obtained as above) will be inversely less or more different from the differences between the individual observations and the mean of the whole of them ; and if there be no periodicity, the two sets of differences would, in a sufficiently long series, be identical.

Hence it may be inferred that when the differences (taken as before) closely approximate in magnitude to the mean difference of the original observations from the arithmetical mean of all of them, the periodical elements in those observations must be correspondingly small ; and this applies manifestly to the eleven year-cycle and to the whole of the arbitrary cycles for which the differences were calculated.

Further to test the reality of the periodicity, the author rearranged the series of sixty-four years' observations, in a purely arbitrary manner, in cycles of eleven years, by drawing the actual observations at random one after another, and setting them down in succession till the whole were exhausted. From three arbitrary cycles thus prepared, the differences averaged 10·9, 11·2, and 11·6—results which again indicate that the actual sequence of the observed quantities of rain has no material effect on the mean differences, or any such tendency to a diminution in their numerical value, which is the necessary accompaniment of a true periodical element.

Moreover, the mere circumstance of any series of cyclical means showing a single maximum and single minimum gives no real indication of such a result being a truly periodical feature. It is obviously to argue in a circle, first to assume a cycle on which to work, which shall give a single maximum and minimum, and then to infer that there is true periodicity because of the single maximum and minimum. The test of the periodicity is in truth to be sought altogether outside of the particular values of the successive elements of the cyclical means.

It is manifest that a complication of periodical elements may so mask one another as to prevent positive results being obtained by the examination of the means and differences in the case before us. But the whole scope of the present argument is negative, and it leads to the conclusion that there is no proof of greater tendency to periodicity in the eleven-year means than in the original isolated observations.

As the sun-spot period is not exactly a cycle of eleven years, the author examined the results obtained by a comparison of the observations corresponding to the known periods of maximum and minimum sun-spots, without reference to any special length of cycle. These results he also considered to be negative.

A further test of the character of the conclusions was sought from the rainfall observations at Bombay and Calcutta, which have been made for the greater part of the period over which those at Madras extend. It is hardly conceivable that there should be a coincidence with the sun-spot period, such as is supposed to have been found at Madras, based on any physical cause, which should not in some way be discernible in the rainfall at Bombay and Calcutta.

The results thus got are also held to be entirely negative, and to indicate no concordance among the means of the several years of the cycle at the different places. The Bombay and Calcutta observations, treated as those of Madras were, to ascertain the deviations of individual observations from the successive means of the cycle, give quite similar results.

Although the special object of the communication was to deal with the alleged correspondence between the Madras rainfall and the sun-spot periods, the author had also turned his attention to Mr. Meldrum's speculations of a similar character, and had tested some of them in the manner explained.

Among these were the Greenwich observations for fifty-five years, which will be found at p. 307 of vol. xxi. of the *Proceedings* of the Royal Society, and the results got from them were quite analogous to that obtained from the Indian observations.

Further, to illustrate the argument on which the paper was based, the case was considered, in which a well-ascertained periodicity exists, as that of the diurnal barometric oscillation. The figures used were taken at random from an old Madras register, the intervals being made two-hourly, and the entries and the differences of the observed barometric heights from the daily means in thousandths of an inch, so as to reduce the calculations.

The figures being merely illustrative, the circumstance of their not exactly representing any physical phenomenon was a matter of no significance.

The treatment of these figures led to results very different from those got from the rainfall observations. The mean difference of all the supposed observations from the mean of all of them being thirty, the mean of the differences between the two-hourly means and the original figures was reduced to seven, indicating the distinct presence of a periodicity.

Re-arranging the figures in an arbitrary cycle of ten periods instead of twelve, the mean of the differences which before was seven was increased to thirty, showing that with the total destruction of the periodicity the mean difference of the two-hourly means and the original figures was the same as the mean difference with the arithmetical mean of all of them.

In conclusion, the author specially explained that he did not call in question the possible or actual occurrence of terrestrial phenomena corresponding to the sun-spot period, but only desired to point out that in the case of the rainfall observations under review the evidence was not sufficient to establish either any periodicity or such a correspondence.

In some remarks made subsequently the author pointed out how the comparison of the successive combination of the observations, beginning with one cycle and then combining two, and so on, till the whole were united, supplied another way of treating the figures which showed that the successive means of the differences between the mean rainfall for the combined cycles and the mean for the several years of the cycle when combined, followed the law that would hold good if there were no appreciable periodicity, that is to say, that this mean should gradually diminish in a ratio inverse to the square root of the number of cycles combined.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Humphry has been appointed to represent the University at the 400th anniversary of the University of Upsala in September next.

Prof. Adams' report to the observatory syndicate for the year from May, 1876, to May, 1877, does not contain anything of unusual interest. The year has been exceptionally favourable for astronomical observations, and 3,618 observations were made with the Transit circle. All the publications of the observatory are well forward, and the general work has been carried on smoothly and efficiently.

The following awards have been made for proficiency in natural science at St. John's College :—To F. T. S. Houghton, a foundation scholarship, the Wright's Prize, and augmentation of exhibition to 100*l.* for the past year. To Marr, Slater, F. J. Allen, Stewart, augmentations of exhibitions.

LONDON.—A public meeting in support of the London School of Medicine for Women was held the other day at St. George's Hall, the especial object being to raise 5,000*l.*, with a view of enabling the Executive Council to carry out an arrangement with the authorities of the Royal Free Hospital, under which students from the school were to receive clinical instruction. Mr. Cowper-Temple, M.P., Mrs. Garrett-Anderson, and Mrs. Westlake were amongst the speakers. 2,600*l.* have already been subscribed.

The Senate of the London University have decided by a majority of five not to postpone giving medical degrees to women till all the other faculties were open to them.

MANCHESTER.—On Friday last the scholarships and prizes gained during the session by students in the Faculties of Arts, Science, and Law were distributed at the Owens College. The Dalton Senior Mathematical Scholarship was gained by J. P. Whitney ; the Dalton Junior Mathematical Scholarship by J. D. Pennington ; the Dalton Chemical Scholarship by J. K. Crow ; the Platt Physiological Scholarship by L. Larmuth. Mr. Crow presented a research upon the "Hypovanadous Compounds,"